Claims

1. A Rotary Vector Gear for sequencing a controlled axis about a reference axis, comprising:

a concentric drive sleeve adapted to rotate about the reference axis;

a first stage eccentric sleeve connected to said driven inner sleeve;

a second stage eccentric sleeve adapted to rotate about the controlled axis;

an external tooth cycloid disc attached to said second stage eccentric;

an internal tooth stationary cycloid ring adapted to be attached to an outer housing for retaining the cycloid system; and,

drive means for rotating said concentric drive sleeve.

2. The device of claim 1 further comprising control means for operating said drive means and thereby sequencing said controlled axis in a predictable manner.

3. The device of claim 1 wherein the controlled axis moves in a hypotrochoidic pattern with respect to the reference axis whenever said concentric drive sleeve is rotated by said drive

4. The device of claim 1 wherein said control means is further adapted to retain the relative position of the controlled axis with respect to the reference axis and respond to external signals whereby the controlled axis may be further placed in a known position with respect to the reference axis.

5. The device of claim 2 wherein said outer housing is the outer housing of a rotary steerable tool having two ends adapted for use in a wellbore and further adapted to receive a drillstring and wherein said cycloid system provides an offset to the drillstring from the center of the wellbore thereby resulting in bit point or bit push directional steering set by the configuration of the cycloid system contained within the rotary steerable tool

6. The device of claim 5 wherein said configuration comprises a single cycloid system positioned near the mid point and between two spherical bearings positioned at the ends of said rotary steerable tool thereby providing angular change of to said drillstring resulting in

bit point directional steering.

7. The device of claim 5 wherein said configuration comprises two co-joined cycloid systems respectively positioned near the ends of the rotary steerable tool thereby providing axial offset to said drillstring resulting in bit push directional steering.

8. The device of claim 5 wherein said configuration comprises a single cycloid system positioned near one end of the rotary steerable tool and further comprises a spherical bearing positioned the other end of the rotary steerable tool thereby providing angular change to said drillstring resulting in bit point directional steering.

9. The device of claim 5 wherein said rotary steerable tool incorporates an inertial guidance system adapted to provide wellbore position reference and wherein said control system is adapted to communicate with said rotary steerable tool.

10. The device of claim 9 wherein said rotary steerable tool is further adapted to communicate with the surface thereby providing on demand directional steering while controlling the dog-leg severity of said directional steering.

11. A Rotary Vector Gear for sequencing a controlled axis about a reference axis within a wellbore, comprising:

a concentric drive sleeve adapted to rotate about the reference axis;
a first stage eccentric sleeve connected to said driven inner sleeve;
a second stage eccentric sleeve adapted to rotate about the controlled axis;
an external tooth cycloid disc attached to said second stage eccentric;
an internal tooth stationary cycloid ring adapted to be attached to the inside of the outer housing of a rotary steerable downhole tool having a central longitudinal;
a drive means for rotating said concentric drive sleeve; and,
control means for operating said drive means and thereby sequencing said controlled axis in a predictable manner
wherein the rotary steerable housing contains said drive means and said

control means and wherein said controlled axis and the central axis of the wellbore are superimposed one to the other.

12. The device of claim 11 wherein said cycloid system provides bit point or bit push directional steering set by the configuration of the cycloid system contained within the rotary steerable tool.

13. The device of claim 12 wherein said rotary steerable tool is adapted to receive a drillstring and wherein said outer housing of said rotary steerable tool has two ends and wherein said configuration comprises a single cycloid system positioned near the mid point and between two spherical bearings positioned at the ends of said rotary steerable tool thereby providing angular change of to said drillstring resulting the bit point directional steering.

14. The device of claim 12 wherein said configuration comprises two co-joined cycloid systems respectively positioned near the ends of the rotary steerable tool thereby providing bit push directional steering.

15. The device of claim 12 wherein said configuration comprises a single cycloid system positioned near one end of the rotary steerable tool and further comprises a spherical bearing positioned the other end of the rotary steerable tool thereby providing bit point directional steering.

16. The device of claim 11 wherein said control system incorporates sensors adapted to provide wellbore reference data and wherein said control system may make real-time adjustments to said controlled axis thereby influencing the wellbore path.

17. The device of claim 16 wherein said control system incorporates a command protocol so that adjustments in wellbore path may be commanded from the surface.

18. The device of claim 17 wherein the dog-leg severity of the wellbore path is controlled.

19. A Rotary Vector Gear for sequencing a controlled axis about a reference axis adapted for use within a rotary steerable tool wherein the rotary steerable tool is adapted for use in a wellbore and provides control of the wellbore path, comprising:

a concentric drive sleeve adapted to rotate about the reference axis;

a first stage eccentric sleeve connected to said driven inner sleeve;

a second stage eccentric sleeve adapted to rotate about the controlled axis;

an external tooth cycloid disc attached to said second stage eccentric;

an internal tooth stationary cycloid ring adapted to be attached to the inside of the outer housing of a rotary steerable downhole tool having a central longitudinal;

a drive means for rotating said concentric drive sleeve;

control means for operating said drive means and thereby sequencing said controlled axis in a predictable manner thereby controlling the dog-leg severity of the wellbore path; and,

wherein said controlled axis and the central axis of the wellbore are superimposed one to the other,

wherein the rotary steerable housing contains said drive means and said control means, and

wherein said control system incorporates sensors adapted to provide wellbore reference data and wherein said control system may make real-time adjustments to said controlled axis thereby controlling the wellbore path.

20. The device of claim 19 wherein said control system incorporates a command protocol so that adjustments in wellbore path may be commanded from the surface.

21. The device of claim 20 wherein adjustments to dog-leg severity may be made from the surface.